

WHAT IS CLAIMED IS:

- 1 1. A low resistivity silicon electrode adapted to be mounted in a plasma
2 reaction chamber used in semiconductor substrate processing, comprising:
3 a silicon electrode having an electrical resistivity of less than 1 ohm-cm, the
4 electrode having an RF driven or electrically grounded surface on one side thereof,
5 the surface being exposed to plasma in the plasma reaction chamber during use of
6 the electrode.
- 1 2. The electrode of Claim 1, the electrode comprising a showerhead
2 electrode having a plurality of gas outlets arranged to distribute process gas in the
3 plasma reaction chamber during use of the showerhead electrode.
- 1 3. The electrode of Claim 2, wherein the gas outlets have diameters of
2 0.020 to 0.030 inch and the gas outlets are distributed across the exposed surface.
- 1 4. The electrode of Claim 1, wherein the electrode comprises single crystal
2 silicon or silicon carbide having heavy metal contamination of less than 10 parts
3 per million.
- 1 5. The electrode of Claim 1, wherein the electrode comprises an
2 electrically grounded upper electrode of a parallel plate plasma reactor.
- 1 6. The electrode of Claim 1, wherein the electrical resistivity of the
2 electrode is less than 0.1 ohm-cm.
- 1 7. The electrode of Claim 1, wherein the electrical resistivity of the
2 electrode is less than 0.05 ohm-cm.
- 1 8. A plasma etch reactor having an electrode assembly which includes the
2 electrode of Claim 1, the electrode being bonded to a support member by an

3 elastomeric joint, the elastomeric joint comprising an electrically conductive
4 elastomeric material between the electrode and the support member, the
5 elastomeric material including an electrically conductive filler which provides an
6 electrical current path between the electrode and the support member.

1 9. A plasma etch reactor having an electrode assembly which includes the
2 electrode of Claim 1, the electrode being resiliently clamped to a support member
3 by a clamping member.

1 10. A plasma reaction chamber including the showerhead electrode of
2 Claim 2, the showerhead electrode being bonded or clamped to a temperature-
3 controlled member in an interior of the plasma reaction chamber, the temperature-
4 controlled member including a gas passage supplying a process gas to the
5 showerhead electrode, the temperature-controlled member including a cavity and at
6 least one baffle plate located in the cavity, the gas passage supplying process gas
7 so as to pass through the baffle prior to passing through the showerhead electrode.

1 11. A method of processing a semiconductor substrate in a plasma reaction
2 chamber wherein an electrode assembly includes an RF driven or electrically
3 grounded silicon electrode having a resistivity of less than 1 ohm-cm, comprising:
4 supplying a semiconductor substrate to the plasma reaction chamber;
5 supplying process gas to an interior of the plasma reaction chamber;
6 energizing the process gas to form a plasma in contact with an exposed
7 surface of the semiconductor substrate;
8 processing the substrate with the plasma.

1 12. The method of Claim 11, wherein the semiconductor substrate
2 comprises a silicon wafer and the method includes etching a dielectric or
3 conductive layer of material on the wafer.

1 13. The method of Claim 11, wherein the method includes depositing a
2 layer of material on the semiconductor substrate.

1 14. The method of Claim 11, wherein the electrode comprises an upper
2 electrode of a parallel plate plasma reactor, the electrode being supplied RF power
3 during processing of the substrate.

1 15. The method of Claim 11, wherein the electrode comprises an upper
2 electrode of a parallel plate plasma reactor, a lower electrode of the parallel plate
3 plasma reactor being supplied RF energy of at least one frequency and the upper
4 electrode being electrically grounded during processing of the substrate.

1 16. The method of Claim 11, wherein the electrode comprises an
2 electrically grounded, non-powered single crystal silicon showerhead electrode
3 bonded or clamped to a temperature-controlled member through which the process
4 gas is supplied to the showerhead electrode, the grounded showerhead electrode
5 providing a ground path effective to confine the plasma and the substrate
6 comprising a silicon wafer which is subjected to etching by the plasma.

1 17. The method of Claim 11, wherein the electrode comprises an RF
2 driven single crystal silicon showerhead electrode bonded or clamped to a
3 temperature-controlled member through which the process gas is supplied to the
4 showerhead electrode, the showerhead electrode forming the plasma by energizing
5 the process gas and the substrate comprising a silicon wafer which is subjected to
6 etching by the plasma.

1 18. The method of Claim 11, wherein the electrical resistivity of the
2 electrode is less than 0.1 ohm-cm and the electrode comprises zero defect single
3 crystal silicon or silicon carbide having heavy metal contamination of less than 10
4 parts per million.

1 20. The method of Claim 11, wherein the electrode includes gas outlets
2 through which the process gas passes into the chamber, the gas outlets having
3 diameters of 0.020 to 0.030 inch and the process gas comprising an etchant gas,
4 the electrode exhibiting less build-up of polymer byproducts within the gas outlets
5 and on a backside of the electrode during etching of the substrate with the etchant
6 gas compared to a conventional electrode having 0.033 inch diameter gas outlets.